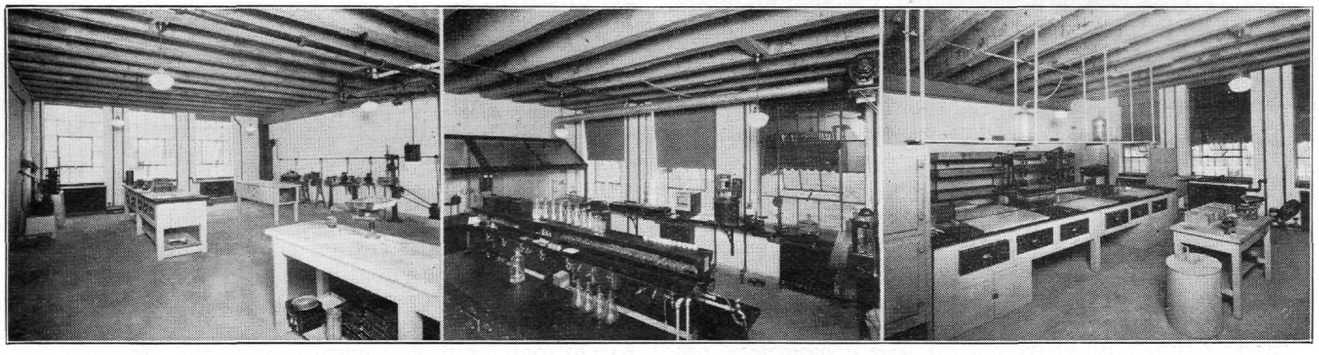
Testing Ohio's Road Materials

The Laboratory of the Ohio State Highway Department

By DAVID B. CHANCELLOR, '30

Ohio's yearly investment of $20,000,000 for highways means that she must maintain a competent organization to keep from "getting bit" in the materials which she buys. The stone used in macadam roads must be hard and tough enough to stand the gaff; concrete pavements must be as thick as specified and strong enough to stand up under grinding tractors and pounding trucks; asphalt must be elastic enough to keep from cracking and hard enough to keep the unwary pedestrian from miring in the middle of the street on a hot summer day.

The testing laboratory of the Ohio State Highway Department is located on the Campus of the Ohio State University, occupying almost the entire second floor of the Engineering Experiment Station Building. There is no official connection with the University, but Experiment Station testing machines are used for work on some highway materials, and the activities of these two departments are coordinated in every possible way.



The Testing Laboratory

In the busy season, when highway construction is going full blast, and materials have to be passed upon as construction proceeds, the testing laboratory is an active place. Materials are arriving in sacks, boxes, barrels and cans, by freight, express, and personal messenger. Tests are proceeding in every part of the laboratory, to determine how these materials behave when subjected to various treatments which simulate the conditions of actual service, excessive heat and cold, freezing and thawing, sunlight and dashing rain, corrosive gases and alkalies, vibration from trolley cars, and blows from heavy trucks.

The Fate of a Concrete Cylinder

Let us examine some of these materials and see what tests are performed, what treatments they are subjected ot, in order to determine the fitness of the materials they represent to become a part of Ohio's highway structure. Here are cylinders of concrete, representative samples of the pavement which has been laid in, perhaps, Tuscarawas County. Taken directly from the soft concrete behind the mixer, the samples have been poured into brow cardboard moulds six inches in diameter and twelve inches high, protected from the drying heat of the sun, and, after hardening, covered with damp cloths or damp sand. Each cylinder must be shipped with care to avoid breakage in transit.

Arrived at the testing laboratory, the samples must be kept for a few days until they are old enough to be tested—28 days is the period which has been accepted as standard among concrete investigators. A greenhouse atmosphere would be admirable for curing the concrete, as warmth and moisture help in the hardening of the cylinders. The storage room at the testing laboratory, consequently, is a moist place. The walls and floors are lined with pitch, and the air is kept saturated by sprays of water.

When the cylinder has reached maturity, the bottom is given a smooth coating of cement and plaster of paris, which makes all the blocks uniform. Finally, the sample is placed in the Olsen Compression Machine and a pressure applied gradually, until it is no longer able to stand the strain and generally crumbles. "But you should be around some time when a block lets go with a bang," said Gus Timmons, who runs this powerful machine. The crushing force in pounds is recorded for each sample, some of the blocks withstanding a pressure of over 100,000 pounds, or more than 3,000 pounds to the square inch.

Testing Road Tar

Each sample of road tar, asphalt, or other bituminous product that comes in to the Bituminous Laboratory of the Highway Laboratory is given a serial number when it arrives. Here we have sample No. 711, sent in by the inspector (who is perhaps a recent Civil Engineering graduate getting his early experience) on the Ohio River Road in Lawrence County.

The bitumen is first given a consistency test

(this indicates whether the material will be firm or sticky in warm weather). Will it dry out and be cracked or crumble? To find out about its nature in this respect, it must be subjected to the distillation test. When the tar is heated in a retort, the amount of light oils passing off at certain temperatures is determined. Other properties, viscosity, specific gravity, and solubility in benzol, must be compared with standard products before sample No. 711 is given its final O. K.

The Chief Chemist in charge of the bituminous laboratory is a stockily built man with a good-humored youngish face and graying hair, Mr. McKercher. He was very pleasant and genial about explaining things in the laboratory. "All materials," said Mr. McKercher, "must come up to specifications which, for the sake of uniformity, are generally those of the American Society for Testing Materials. The apparatus, consequently, must be standard, and must be checked with that of the Bureau of Public Roads. Otherwise, a whole carload of acceptable material might be condemned because of faulty testing instruments."

Ordeals for Paving Materials

Mr. Frank Loren explained all the tests which are made to determine the durability of brick, stone, gravel and sand. The rattler or abrasion test is pretty rough treatment for paving material. This instrument of torture is concealed from public view in a box along the wall. Running through this box is a sort of crankshaft on which, at intervals, are mounted good-sized metal cylinders whose axes are tilted at angles of thirty degrees with the axis of the shaft. It is easy to imagine what happens to the unlucky specimen in the cylinder when the shaft is rotated; the noise is tremendous; plunges in rapid succession from one end of the cylinder to the other produce a series of knocks and blows which quickly round off sharp edges and corners, and unless the specimen is made of sturdy stuff, disintegration may ensue. When the trial has proceeded for the specified 1,000 revolutions, the samples are removed and the loss is determined by weighing the residue above a certain size.

In rattling gravel, which has rounded corners to begin with, steel balls are added to the charge in each cylinder. These balls are not necessary for broken stone because the angular edges produce high losses early in the game.

The devices for separating stone and sand into graded sizes are very interesting. Sand is shaken through nine sieves for fifteen minutes by an eccentric device attached to a motor. The coarsest sieve is in the top, the finest in the bottom, with graduations between so that the amount able to squeeze through and be retained on each size can quickly be determined. Stone is not so easily sifted, because some particles which are very much longer than they are wide or thick would be held on a screen of a certain size unless poked through in a lengthwise direction, and must receive personal attention. The stone sifting device is called a cradle. The screens, which are in wooden boxes, are stacked one on top of the other, the largest, at the top, having two-inch openings, the smallest, at the bottom, being one-quarter inch. The whole stack is mounted on skids with rounded bottoms and projecting ends, so that most of a sample which is poured in at the top can be rocked through to the proper screens by a reciprocating pedal motion. When further rocking produces no effect, the stone retained on each screen must be turned to see if any more may be forced through.

A stone's ability to stand the rattler test is not the only guarantee of fitness required. There is the wear, or grinding, test. A cylinder of the material having a certain cross section area is held with a certain weight or pressure against a rotating steel disk, sand trickling from funnels above the disk provides plenty of grinding material. The result is expressed in a very funny and arbitrary unit known as the French Coefficient of Hardness, so-called because such tests were first performed in France. The loss in grams is divided by three and subtracted from twenty. The result is, of course, no physical unit, but serves for purpose of comparison with the similar test on other stones.

Hardness and wearing quality alone will not indicate a stone's fitness for use in a pavement. The material must be tough enough to withstand blows from the calks of horses shoes and the pounding of chains on heavy trucks. The impact testing machine is very unusual. The little sample of stone, one square inch in area and one inch high, is subjected to a series of blows from a two-kilogram weight, faling first from a height of one centimeter, then two, increasing one centimeter each time until the blow produces fracture. The toughness recorded is the height through which the weight fell to produce the fatal blow.

Sun Baths for Paint

The laboratory is nothing if not up-to-date. Human beings who cannot acquire the Florida tan by basking in the sunshine of Palm Beach, remain healthy and vigorous in gloomy winter climates by bathing in ultra violet rays. What is good for human beings, however, may not be good for paint. A coating which is designed for protection and visibility along the highways may serve its purpose admirably until tanned by torrid rays of sunlight. Obviously the problem is to select paints which offer the greatest resistance to this kind of weathering, and the great difficulty is selecting this kind of paint without waiting for years of actual service. Science has come to the rescue, however, and ultra violet rays which have been discovered to be the most active principle in sunlight may be generated in the laboratory in such concentration as to produce in the sample in a short time the same effect as years of exposure to sunlight. Bright sunshine after a shower is perhaps the most gruelling test of all. This condition is duplicated by directing the stream of ultra violet rays on the sample which is immersed in a shallow pan of water. This test is new and standards are just now being determined so that comparisons may be made.

Bigger and Better Tests

Testing is such a big subject that an exhaustive treatment would certainly be exhausting. There's freezing, for instance. The physical characteristic of water which causes it to have its smallest volume at four degrees Centigrade is doubtless of immense value in keeping our lakes and rivers

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from becoming bodies of solid ice, but certainly is a destructive factor on construction material. Samples of stone and brick may of course be frozen and thawed, but comparable results are obtained more easily and in shorter time by the sodium sulfate process. The dry and thirsty sample is given as much sodium sulfate solution as it will soak up. Drying in an oven causes the sodium sulfate to crystallize with an expansive force which has been found to be practically equal to that of freezing water. Five of such freezings and thawings are considered sufficient to test the mettle of the sample. If it doesn't break, it is marked O. K. in this particular.

There are other tests, cement for instance. Would you believe it if you were told that standard cement must have a specific gravity between 3.1 and 3.2, and almost in the same breath that a sack of cement weighs 94 pounds and is considered one cubic foot? Before you jump on this as a sample of rotten mathematics, remember that cement grains are very fine and light and puffy, and that more than half the cubic foot is not cement but merely air between the particles.

So, of course, there must be a specific gravity test for cement. And a tensile strength test. And a soundness test. Many of the tests on cement are made directly at the factory where the cement is manufactured, but of course all of them may be performed in the laboratory.

Yes, during the construction season, the State Highway Testing Laboratory is a very busy place. All kinds of tests are going on. Typewriters are clicking, recording the tests which are then sent out for the guidance of the field engineers. There's research work, too, for the making of tests which have already been worked out is not enough. Tests and standards for new materials and new tests for old materials are required to keep pace with discovery and developments in manufacturing and construction. The State Highway Testing Laboratory is a busy, growing department of the State Government, a safeguard to insure that the people get their money's worth for their investments in highway material.